Space Weather Technical Forecast

Issued on Saturday, 22 October 2022 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor to G2/Moderate Storm, mainly Day 2 (23rd)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Low, with only a few small C-class flares observed. There are currently three sunspot regions on the visible Sun, however these are all currently small and simple regions. The most developmental is newly numbered AR3128 Cai/Beta in the southwest, having developed a dark umbra on its leader, but only small surrounding spots. AR3126 Dao/Beta and AR3127 Hax/Alpha in the centre disc are both stable, with no sign of further growth. The central disc dimming observed early on the 22nd has not produced a visible CME, with no other Earth-directed CMEs observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was mostly at background with speeds, falling from initially slightly elevated levels of 420km/s to around 350-400km/s for much of the period. The density of the wind, however, exhibited a gradual but also erratic rise, from below average levels to above average levels around 12-18ppcc by 22/0000 UTC. The total IMF strength, Bt, also erratically rose from being weak at 4-6nT to peak at moderate values of 8-10nT. The north-south component Bz remained weak throughout however, varying between -4nT to +6nT, and mostly positive (northward) from 21/1045 UTC. The phi angle was initially negative (towards the Sun), but rotated to positive (away from the Sun) at 21/1045 UTC. Geomagnetic activity was Quiet with isolated Unsettled intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was mostly Moderate, but very briefly reached High levels, with a peak flux of 1160pfu recorded at 21/1555UTC. The associated 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold, with 3.29e7 integrated pfu observed at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is most likely to continue Low, perhaps falling to Very Low, but with a daily slight chance of an isolated M-class flare.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds are expected to see a gradual transition into the fast wind of CH34 on day 1 and into day 2 (22nd and 23rd), with solar winds becoming Elevated. This is low confidence in both timing and strength, and is mainly guided by current enlil expectations as well as a notable enhancement observed by STEREO A. The fast winds will likely persist day 3 (24th), before potentially easing day 4 (25th). Geomagnetic activity is expected to rise from Quiet day 1 (22nd) to be Unsettled to Active with an increasing chance of G1/Minor to G2/Moderate storms either later day 1 or more likely day 2 (23rd). Quiet to Unsettled with isolated Active intervals then expected day 3 and day 4 (24th and 25th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be at Background. High energy electron flux (greater than 2MeV) as observed by

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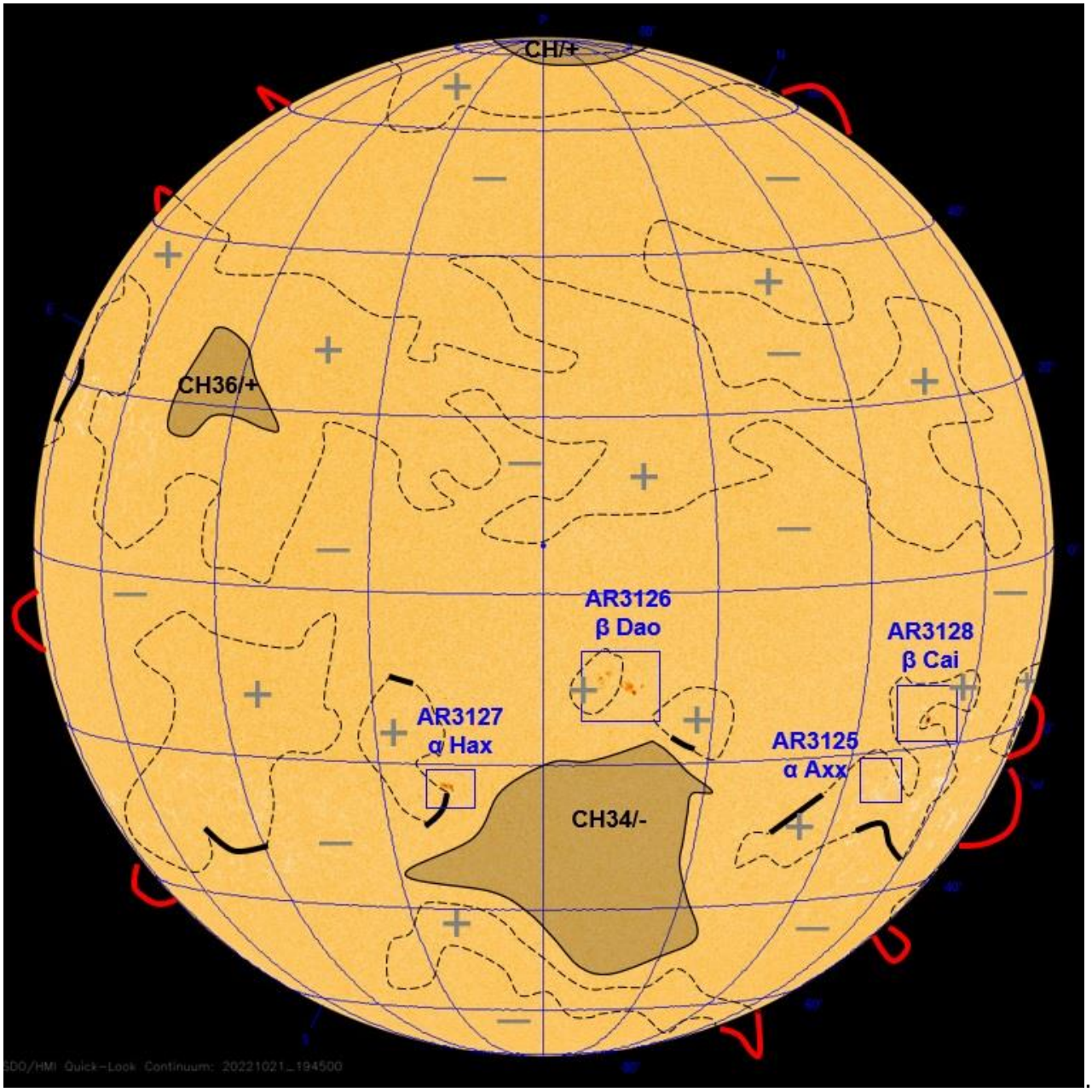
GOES16 is expected to be peak at Moderate, perhaps briefly High day 1 (22nd) before dropping out with any fast wind arrival later or on day 2 (23rd). A gradual rise to mainly High levels is then expected by the end of the period. The associated 24 hour fluence is expected to remain below Active (1e8 integrated pfu) at first, before rising late in the period, with a chance of rising above day 4 (25th).

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs. The main feature of interest for this forecast period is the large southern negative polarity coronal hole 34. This is a recurrent CH with similar appearance to the previous rotation and, with persistence indicating an arrival on day 3 (24th), and resultant solar wind speeds of 550km/s. Conversely, however, MOSWOC enlil is indicating an arrival on day 1 (22nd), with solar winds peaking at 600km/s early day 2 (23rd). The latter of these is currently accepted as most likely, given current observations at STEREO A.

STEREO A, which samples the solar wind around 1.4 days before it reaches Earth, has already observed a significant increase in both density (peaking near 295ppcc), and total magnetic field (Bt) approaching 25nT. However, the solar wind speed has yet to show a significant increase. A potential cause of this, would be STEREO A, which is currently north of the ecliptic, having a prolonged period in the CIR of CH34, as it passes through the northern boundary between the CH fast wind and the surrounding background slow wind. Alternatively, there remains the possibility that a passing, weak, transient CME is the cause of this enhancement however no potential candidates for this have been observed.

Consequently solar winds at Earth are expected to remain near background speeds until later on day 1 (22nd), before a significant enhancement into day 2 (23rd), likely reaching speeds of around 600-650km/s. These Slightly elevated to elevated winds will likely persist day 3 (24th), perhaps gradually easing day 4 (25th).

Geomagnetic activity is expected to rise from Quiet day 1 (22nd) to be Unsettled to Active with an increasing chance of G1/Minor to G2/Moderate storms either later day 1 or more likely day 2 (23rd). Quiet to Unsettled with isolated Active intervals then expected day 3 and day 4 (24th and 25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	60	10	1
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2a: Solar Wind Persistence showing arrival of fast wind on 24th.

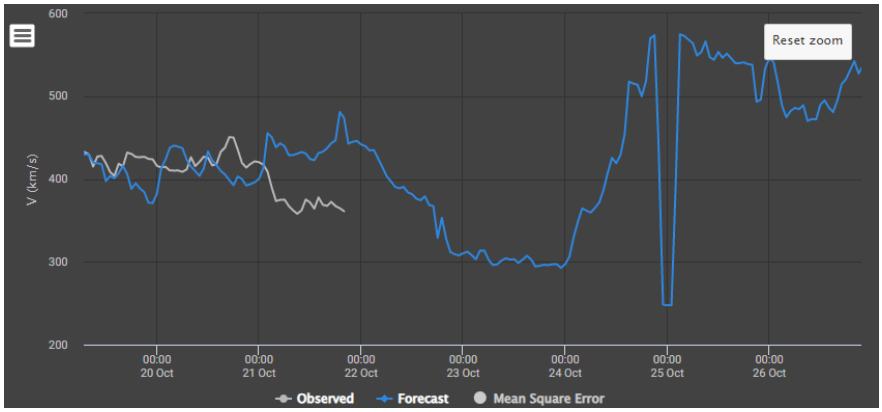


Figure 2a: Enlil Forecast showing arrival of fast wind on 22nd.

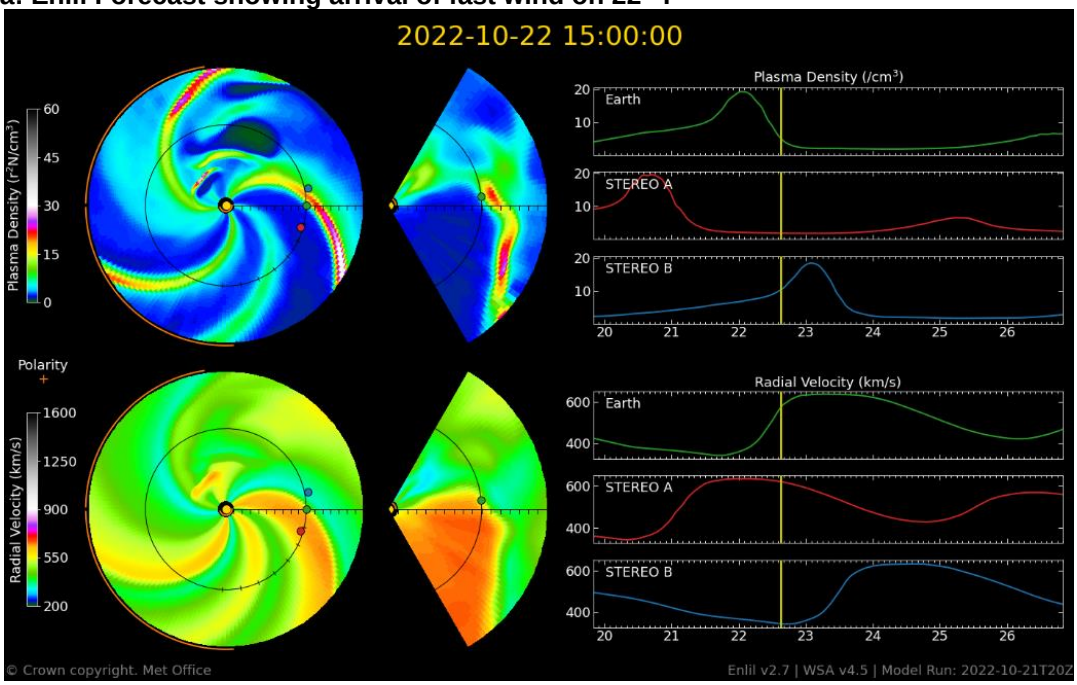
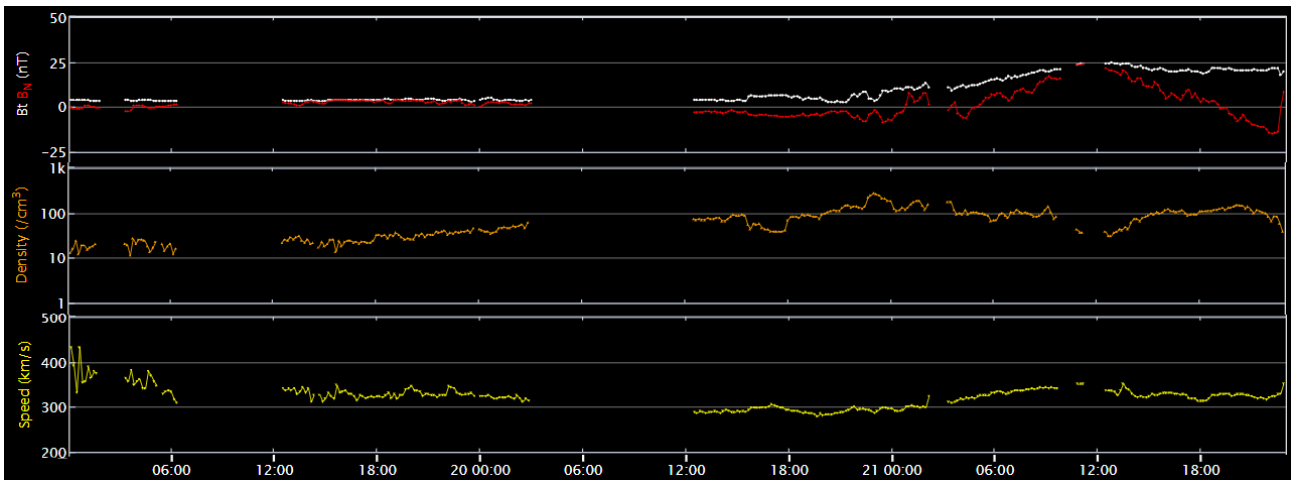


Figure 2a: STEREO A observed winds for the last 3 days. Strong enhancement observed, despite speeds remaining at background.



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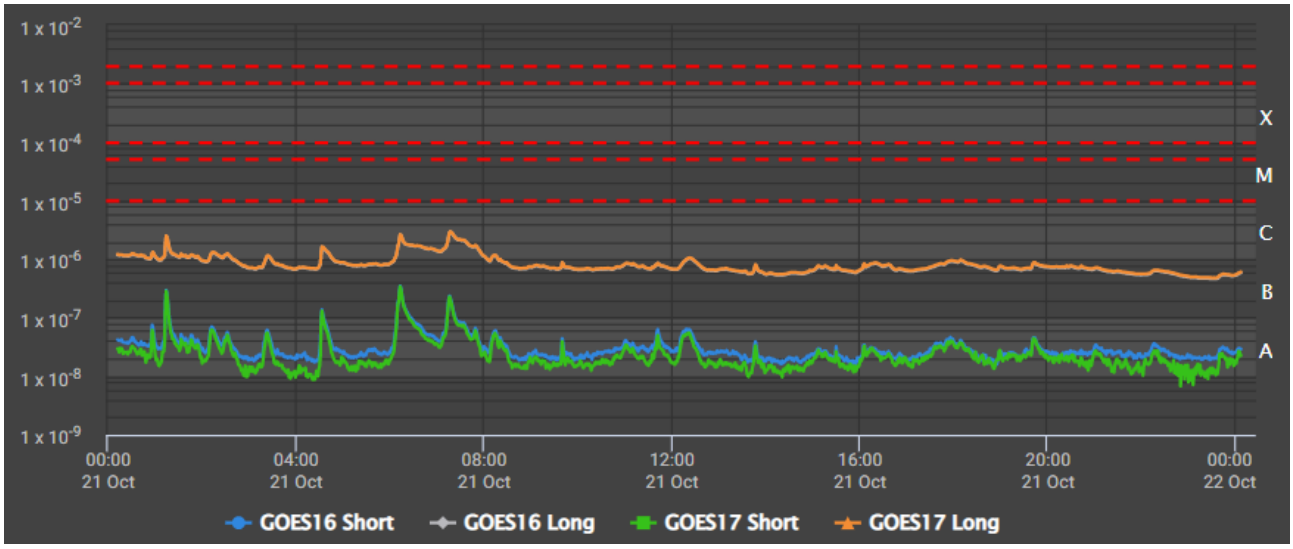
Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with three sunspots on the Earth-facing disc. Low activity is expected to continue, perhaps falling to Very Low, but with a slight chance of increasing to Moderate from any flare activity.

The three region on the disc are all relatively small and simple, although a recently numbered region, AR3128 Cai/Beta in the southwest continues to show signs of development. The leader of this region has a distinct and dark umbra however the surrounding spots remain small. AR3125 Dao/Beta and AR3127 Hax/alpha are more persistent areas closer to the southern centre disc, but both are small and stable with simple magnetic structure. AR3125, in the southwest, has now faded to plage and is no longer visible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16/17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES16 is currently at Background and expected to stay at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 has been varying between background and Moderate, perhaps briefly high levels, for a number of days, and little change is expected day 1 (22nd) before the arrival of the fast wind of CH34. There is significant uncertainty on both the timing and strength of this arrival, and hence in any subsequent increase in the observed electron flux. As solar wind pressure eases through day 3 and day 4 (24th and 25th), flux levels are likely to rise and are expected to become mainly High by the end of the period.

The associated 24 hour electron fluence is expected to remain below Active, but rising late in the period, especially as solar winds ease. There is a chance of Active fluence by day 4 (25th). REFM is providing good guidance until T+24, but should be used cautiously beyond this due to the potential earlier fast wind arrival compared to persistence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	2	5

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Figure 4: GOES-16 >2MeV Flux and associated Fluence with REFM.

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